PULSED FIELD USERS PROGRAM
ATTENTION USERS

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Don Kim, Al Migliori, and co-workers have successfully taken a novel instrumentation design concept and created a new sensor for use in high magnetic fields. Funded by the NHMFL In-House Research Program, this success story marks a significant step forward in thermo-physical sensor development. The method known as the "Three-ω" technique is a powerful way in which researchers can determine the thermal conductivity (or thermal diffusivity) of a sample with great accuracy in a very short period of time (sub milli-second). Such a technique is ideal for users of pulsed magnetic fields in which the field often sweeps at rates of 2000 to 20,000 T per second. Below is an example of the power of this new tool available to users of the NHMFL.

3-ω Thermal Conductivity Studies in Pulsed Fields

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Why measure thermal conductivity? Resistivity below T_c tells us nothing about the superconducting gap, the physics, or the critical exponents. But heat capacity does! And so does thermal conductivity for similar reasons. That is, superconductivity does not reduce heat capacity or thermal conductivity to zero. Thermal measurements, however, are difficult in the short-pulse magnets that can suppress superconductivity completely in some high temperature superconductors, thus the development of new techniques for these measurement in pulsed magnetic fields is of major importance to the mission of the NHMFL. The results described here as part of an In-House Research Program award are a major accomplishment. What we show in Figs. 1 and 2 are the data taken in a short-pulse magnet that match the results of Fig. 1 in a static magnetic field. Although this demonstration experiment itself is perhaps not of major scientific significance, the fact that one can now, for the first time, look at the thermal conductivity of high temperature superconductors both in the superconducting and normal state (critical field values are ordinarily too large for easily accessible DC magnets) will make possible the extraction of the temperature dependence of the electronic contribution to the thermal conductivity. Such measurements are fundamental since they will yield answers to longstanding questions regarding the electronic density of states and, therefore, order parameter in these complex systems. It is to be noted that these experiments would not be possible if it were not for the pulsed high magnetic fields available at the NHMFL and the newly developed measurement techniques.

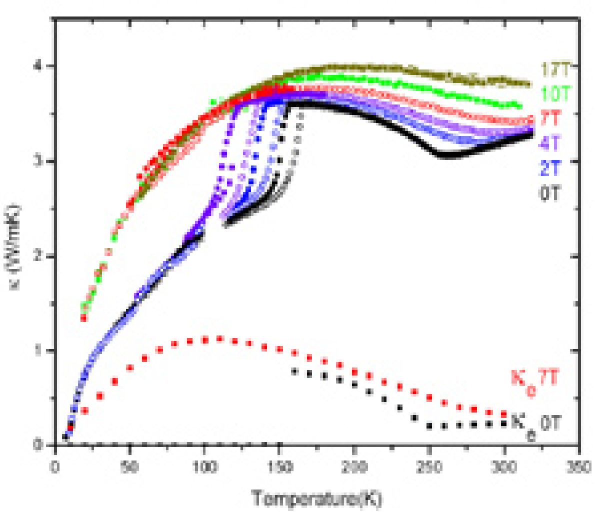

Figure 1. 3-ω measurement of a colossal magnetoresistance material through the field-dependent antiferromagnetic transition.

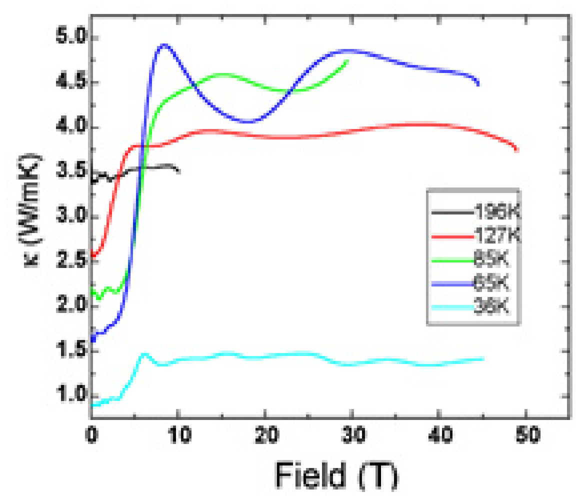

Figure 2. The identical set-up as for Fig. 1 except in a pulsed field. The measurement is a landmark because data were taken with 500 microsecond resolution in a short-pulse magnet. The results clearly show the field-induced antiferromagnetic phase transition. High T_c is next!